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PROCEEDINGS OF THE TWELFTH ANNUAL SCIENTIFIC RESEARCH MEETING



Great Smoky Mountains National Park
May 22-23, 1986



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Uplands Field Research Laboratory
Great Smoky Mountains National Park
Route 2, Box 260
Gatlinburg, Tennessee 37738

Abstracts of the
TWELFTH ANNUAL SCIENTIFIC RESEARCH MEETING

The Uplands Areas of the Southeast Region
National Park Service

Great Smoky Mountains National Park
May 22-23, 1986

Edited by
James D. Wood, Jr.

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WELCOME ADDRESS

A REVIEW OF TWELFTH YEAR ACTIVITIES OF UPLANDS FIELD RESEARCH LABORATORY

John D. Peine, Director
Uplands Field Research Laboratory
Great Smoky Mountains National Park

The year since the Eleventh Annual Scientific Research Meeting in Great Smoky Mountains National Park has been one of seeing several plans solidify, which have significantly expanded the scope of our operations and involvement with other research institutions. The major activities of Uplands Laboratory during the past year are summarized as follows.

Cooperative Park Studies Unit at the University of Tennessee

Under the guidance of Superintendent John Cook and Assistant Superintendent Roland Wauer, a Cooperative Park Studies Unit was established with the Department of Fisheries, Forestry, and Wildlife at the University of Tennessee. Dr. Peter White moved from the Uplands Laboratory to Knoxville as CPSU Leader. This activity will strengthen our already considerable ties with the University of Tennessee.

Man and the Biosphere Program

Proceedings were published on the previous November's Conference on the Management of Biosphere Reserves. I initiated educational activity for MAB by designing and securing funding for an interpretive sign on air pollution and a project to develop a series of MAB-related lesson plans for local school systems. In the arena of preserving genetic diversity, old-growth Fraser fir seed cones were collected and stored, and efforts began to establish a strategy to preserve the southern Appalachian chestnut tree "gene pool." The special session planned later today is a first attempt at bringing scientists of the Southern Appalachian Biosphere Reserve Cluster together to discuss common goals and potential collaborative work specifically oriented to the MAB mission.

Air Quality

The Oak Ridge National Laboratory study directed by Steve Lindberg and Dale Johnson is finally under way, with instrumentation finally in place. The study sites at Noland Divide and Indian Gap include instruments to measure the effects of atmospheric deposition on canopy and soil processes and on elemental accumulation, cycling, and losses in forest ecosystems.

Operation of the Look Rock air quality station continues jointly between David Silsbee of Uplands Laboratory and Larry Killebrew of the State of Tennessee. A new data logger has improved operations. The site has been included as a member station of the new national visibility monitoring network sponsored by EPA which will provide for some equipment updating and expansion. A Southeast Regional workshop on visibility monitoring and regulation was held in the Smokies, sponsored by EPA and the NPS. All southeastern states and Federal land-managing agencies participated.

Spruce-Fir

Chris Eagar has taken over the reins of technical coordinator for the Spruce-Fir Ecosystem Assessment Program, coordinated by the Southern Appalachian Research/Resources Management Cooperative. The establishment of permanent vegetation plots continues in the park. As the program enters its second full year, the scope of data collection in the park will expand significantly.

Botany

Under the direction of Peter White, Mark MacKenzie, and John Rehder, progress continues on the development of a new vegetation map based on a series of multispectral scanner data and aerial photography. Progress has been slowed by the limitations of available imagery and becoming familiar with the Earth Resources Data Analysis System and the Aeronca Electronics Geographic Information System being used for the project. A spruce-fir map has been completed. The hemlock and pine forest types are now under way.

Aquatics

The biggest aquatics news is that Dr. Charles (Chuck) Parker has joined the Uplands staff as an aquatic ecologist. His first assignment toward developing an active program is to complete the work initiated by Mark Alston concerning assessment of stream characteristics as they relate to brook trout habitat.

Wildlife

Greg Wathen is close to finishing his final report on the study of deer ecology and hemorrhagic disease in Cades Cove. He and Dr. John New of the University of Tennessee will report key study findings today.

The hog bait study continues, with refinements of the research methods and a longer list of baits tested. Greg reports on those study findings today as well.

Sociology

This last summer and fall, a team of social science technicians conducted almost 2,000 interviews with park visitors concerning their social characteristics, use patterns, and attitudes. Jim Renfro has been immersed in data entry and analysis ever since and will present key study findings tomorrow.

Again, the Laboratory staff has enjoyed a very productive and hectic year. We look forward to nudging the doors we have opened a little wider so that our relationships with research institutions in the region can continue to grow and flourish.

CENSUS OF A BREEDING BIRD POPULATION IN A VIRGIN SPRUCE-FIR FOREST ON MT. GUYOT, GREAT SMOKY MOUNTAINS NATIONAL PARK, BEFORE AND AFTER BALSAM WOOLY APHID INFESTATION

--Fred J. Alsop, III and Thomas F. Laughlin, Department of Biological Sciences,
East Tennessee State University, Johnson City, Tennessee 37614-0002

In June 1967, a breeding bird survey was conducted using a spot-mapping method on a 24.28-hectare (60-acre) plot in a virgin spruce-fir forest at an elevation of 1,817 m (5,960 ft.) on Mt. Guyot in Great Smoky Mountains National Park. Thirteen species of territorial males were found with a population density of 282+ males per 100 acres. The crown trees of the forest were comprised of 80 percent fir, 16 percent spruce and 4 percent birch. In June 1985, the census was repeated on the same study plot using the same sampling methods. This census was conducted more than a decade after the fir had been infested by the balsam wooly aphid and many of the fir trees had been killed. The forest now had an open canopy and many standing dead trees; many trees had been toppled by wind. Fourteen species of territorial male birds were scored with a population density of 181+ males per 100 acres. Two species found in the 1967 census were not present in 1985 and the latter count had three species not found in 1967 for a net gain of one species, during which time the population density had decreased by a calculated 36 percent. The three dominant species of crown trees on the study site had all decreased in numbers since the 1967 survey. In 1985, fir comprised 2.5 percent of the crown, spruce 80 percent, birch 15 percent and maple 2.5 percent. The ground cover and understory was much thicker than in 1967 and several species of birds not recorded on the study plot then were found in this undergrowth of the more disturbed site. Several bird species that forage and feed on insects in dead wood and that are cavity nesters were more numerous in 1985 than in 1967.

AN OVERVIEW OF THE MOVEMENT ECOLOGY AND POPULATION DYNAMICS OF WHITE-TAILED DEER IN CADES COVE, GREAT SMOKY MOUNTAINS NATIONAL PARK

--William G. Wathen, Uplands Field Research Laboratory, National Park Service,
Gatlinburg, Tennessee 37738

Population dynamics and movement ecology of white-tailed deer (Odocoileus virginianus) in Cades Cove were investigated from 1983 to 1985. The study was conducted in conjunction with a study of infectious diseases in the Cades Cove deer herd. Thirty-nine roadside spotlight counts estimated the overall density at 0.38 deer/ha; however, seasonal densities were significantly variable ($P < 0.001$), ranging from 0.20 deer/ha in winter to 0.55 deer/ha in spring. Monthly population estimates derived by the mark/recapture technique ranged from 430 to 835 ($\bar{x} = 576$ in 1983-84), with no significant difference between seasons. Dawn and dusk roadside counts observed an adult sex ratio of 72 males: 100 does. In 1978-79, the observed sex ratio was 33 males: 100 does. Deer removals conducted from 1980-84 emphasized the removal of does from the population and likely skewed the sex ratio in favor of males.

Fawn at heel counts ranged from 18 to 20 fawns: 100 does in 1983-85, indicating little change in productivity during the study. However, examination of immobilized adult

does during 1983 and 1984 revealed large differences in natality rate between the years. In 1983, only 32 percent of adult does were lactating, compared to 72 percent in 1984. Apparently, the fawn at heel index may not be sensitive to changes in productivity levels.

Movement data were obtained from 21 deer (10 males, 11 females) monitored from 23 to 480 days (\bar{x} = 258 days). The mean annual home range size was 147.2 ha, with males (\bar{x} = 226.9 ha) ranging over significantly larger ($P < 0.01$) areas than females (\bar{x} = 107.3 ha). Adult males (\bar{x} = 263.2 ha) had the largest annual home ranges of the four sex and age class cohorts. Analysis of variance (ANOVA) indicated that annual home range size was significantly affected by sex and the presence of cattle within the home range. Deer with substantial amounts of cattle pasture in their home ranges had significantly larger ($P < 0.05$) range sizes than those that rarely associated with cattle. Seasonally, home ranges were largest during spring (\bar{x} = 74.5 ha) and winter (\bar{x} = 57.6 ha), and smallest during the rut (\bar{x} = 39.0 ha). Adult males exhibited significant shifts in activity centers during the rut but did not significantly increase their movements or home range size. Most seasonal shifts in activity centers were observed from winter to spring (7 of 11), and from spring to summer (5 of 12).

INFECTIOUS DISEASE SURVEY OF THE CADES COVE DEER HERD, GREAT SMOKY MOUNTAINS NATIONAL PARK

--John C. New, Jr., DVM, MPH, University of Tennessee, Knoxville, Tennessee

From 1980-1984, blood samples were collected from 518 deer in the Cades Cove area of the Great Smoky Mountains National Park. Sera from these samples were analyzed for the presence of antibody to hemorrhagic disease (bluetongue virus and epizootic hemorrhagic disease virus), brucellosis, anaplasmosis, bovine virus, diarrhea virus, infectious bovine rhinotracheitis virus, leptospirosis and toxoplasmosis. Positive titers were found for all diseases except brucellosis.

The prevalence of these diseases was compared to host factors such as sex and age, as well as environmental factors such as density, movement and habitat. Analysis of variance was conducted in order to determine the most powerful variable for the diseases of highest prevalence. The impact of infectious diseases on management strategies was discussed.

THE WILD HOG BAIT STUDY IN GREAT SMOKY MOUNTAINS NATIONAL PARK: A PROGRESS REPORT

--William G. Wathen, Uplands Field Research Laboratory, National Park Service,
Gatlinburg, Tennessee 37738

The wild hog (*Sus scrofa*) bait enhancement study was initiated in 1984 as the result of a recommendation by a 1983 Wild Hog Workshop to investigate alternative baits. Six 1/4-acre pens were constructed by February 1985. Initially, it was determined that hogs' preference for various attractants be investigated. This was accomplished nonconsumptively using an incomplete block sampling protocol in which five attractants

were tested against each other in all possible combinations. Measured variables included time spent within 9-m, 6-m, and 3-m perimeters to each attractant, the number of responses to each attractant, and any behavior exhibited by the hogs. Response behaviors were divided into three categories: visual, olfactory, and tactile. A total of 316 hours of observations has been recorded on hog reactions to 28 different attractants. Data analyses are very preliminary and tentative in nature. However, of the test attractants, strawberry and violet fragrance had the highest average reaction time (> 2 minutes per test hour). Creosote had the highest average response rate ($\bar{x} = 3.25$) per test hour. Data analysis on the attractant tests will continue to determine if hogs discriminate between attractants by using our methodology. We also plan to implement bait preference tests this summer and to investigate the use of scent stations in the field as a method to determine preference for attractants.

SYNTHESIS OF VISIBILITY RESEARCH AND MONITORING IN GREAT SMOKY MOUNTAINS NATIONAL PARK: 1978-1986

--David Silsbee, Uplands Field Research Laboratory, National Park Service,
Gatlinburg, Tennessee 37738

The Clean Air Act amendments of 1977 mandated that any existing anthropogenic visibility impairment in Class I airsheds such as Great Smoky Mountains National Park (GRSM) be remedied. Since that time, several studies have addressed the issue of how much the existing visibility conditions in GRSM reflect the influence of air pollution. This presentation summarizes two types of studies: studies of historical data, looking for trends that could be attributed to human influences, and studies of aerosol composition, looking at the chemical composition of the particles responsible for the haze in order to determine their origins.

The studies of historic trends used airport visibility data, dating back in some cases to the early 1930s. Records at the Knoxville airport, the closest site to GRSM, began in 1948. Annual median visibility showed very little change since the beginning of records, with slight decreases in some locations. Summer visibility, on the other hand, consistently showed dramatic declines since the late 1940s and early 1950s. At the Knoxville airport, the decline was more than 50%.

Studies of aerosol composition have also given consistent results, despite considerable variation in method. All studies have shown the fine particle mass to be dominated by sulfate particles, with the percentage varying from 52% to 61%. Sulfate accounts for an even higher percentage of visibility reduction, due to the high efficiency of light scattering by sulfate particles; approximately 75% of the haze is due to sulfate particles. Natural hydrocarbons, which have been cited in the past as the cause of the "smoke" that gives the Smokies their name, made up only a few percent of the aerosol.

DEVELOPING METHODS TO CORRELATE OXYGEN CONSUMPTION AND BREATHING RATE IN RAINBOW TROUT FOR MONITORING ACID PRECIPITATION IN THE SOUTHERN APPALACHIANS

--John F. McFadden, Scott Quisenberry and Eric L. Morgan, Department of Biology, Tennessee Technological University, Cookeville, Tennessee 38505

Methods for correlating oxygen consumption with breathing rate in rainbow trout were developed. This was accomplished by coupling an Automated Biomonitoring device to a respirometer. Positive correlation of the parameters would provide a means of deriving metabolic rates from breathing rate data alone. As a part of the Acid Precipitation Mitigation Program, this information will be used in evaluating stream acidification effects and mitigative liming success in a Southern Appalachian mountain stream.

WATER QUALITY RESPONSE TO PRECIPITATION IN FIVE WATERSHEDS OF THE SOUTHERN APPALACHIANS

--Harvey Olem, Tennessee Valley Authority, Chattanooga, Tennessee

Major storm episodes are frequent in high-elevation watersheds of the Southern Appalachians and account for much of the annual precipitation of 100 to 180 cm. Wet deposition is acidic, the topography is steep, soil cover is shallow, and the geological formations provide little buffering capacity. Rainfall reaches the streams fairly quickly. Preliminary studies indicated that water quality changes dramatically during these events.

Five watersheds were selected for study. Two of the watersheds are in the Great Smoky Mountains National Park (Cosby and Twentymile Creeks) and the others are on surrounding National Forest lands. Twenty storms were sampled during continuous monitoring of precipitation and streamflow between March 1984 and June 1985.

The pH of stream water did generally decrease during these storms, but the chemistry of the streams was different between watersheds even though they received similar levels of acidic precipitation. The relationship of these changes to watershed characteristics, such as forest cover, geology, soils, topography, elevation, and size of watershed are explained.

THE INTEGRATED FOREST STUDY ON EFFECTS OF ATMOSPHERIC DEPOSITION

--S. Lindberg, D. Johnson, D. Silsbee, J. Owens, D. Todd, R. Harrison, D. Schaefer and K. Dearstone, Oak Ridge National Laboratory, Oak Ridge, Tennessee and Uplands Field Research Laboratory, Gatlinburg, Tennessee

The Electric Power Research Institute (EPRI) acid deposition research program is based upon the recognition that forests are complex, long-lived systems and that understanding how pollutants affect the health of forests will come only from long-term basic research on the mechanisms of action. The Integrated Forest Study on Effects of Atmospheric Deposition is one of EPRI's three large, integrated research projects

designed to address the forest effects problem. The principal objective of this study is to evaluate the effects of atmospheric deposition on forest nutrient cycling. Specifically, processes regulating the mobility of sulfate, nitrate, hydrogen ions, base cations, and aluminum will be studied by monitoring the fluxes of these ions from the atmosphere through various forest ecosystems and by altering N, S, and H⁺ inputs in a series of manipulative studies. This presentation will focus on the atmospheric deposition task in general, and on research activities at the Nolan Division spruce site in the Smokies, in particular.

EFFECTS OF ACID PRECIPITATION ON SOIL SOLUTION ALUMINUM: SPRUCE-FIR FOREST, GREAT SMOKY MOUNTAINS NATIONAL PARK

--A. C. Stam, Graduate Program in Ecology, University of Tennessee-Knoxville and the Environmental Sciences Division, Oak Ridge National Laboratory

This research is designed to test the hypothesis that acid precipitation enhances the mobilization and bioavailability of soil aluminum. General objectives are to determine the influence of precipitation pH on the total concentration and speciation (organic complexes versus inorganic complexes plus ionic metal) of Al in the soil solution of the organic soil horizon (Oe and Oi) and on the bioavailability of Al (as inferred from plant tissue concentrations).

Two adjacent field plots were established in the Collins Shelter area in the Great Smoky Mountains National Park. The 3-m-diam plots were isolated from ambient precipitation and watered weekly (Apr. to Oct. 1985) with artificial precipitation pH of 3.5 (treatment) or pH 5.0 (control). The soil solution was collected at 1 h, 1 d, 3 d, and 6 d following watering events in May and October. Soil solution chemistry was monitored using a speciation scheme which determined total monomeric Al (TMA1) and organic monomeric Al (OMA1).

During the May sampling period, there were no apparent treatment effects on either the TMA1 or OMA1 fractions. Individual sample concentrations of TMA1 ranged from 0.4 to 1.4 ppm (treatment) and from 0.4 to 2.1 ppm (control), with the highest concentrations occurring at day 6. Organic monomeric Al (OMA1) composed from 15 to 30% of the TMA1. This fraction increased from 1 h to 1 d and remained relatively constant after that time.

During the October sampling period, there were treatment effects on both TMA1 and OMA1. Over the six-day sampling period, concentrations of TMA1 ranged from 0.5 to 5.4 ppm (control) and from 0.6 to 3.9 ppm (treatment). In the 1 h and 1 d samples, the mean concentration of TMA1 were higher in the treatment (1.9 and 2.2 ppm) than in the control (1.7 and 1.4 ppm), but these differences were not statistically significant. At 3 and 6 d, mean concentrations of TMA1 were greater in the control (3.5 and 3.4 ppm) than in the treatment (1.5 and 2.3 ppm) ($p < 0.05$). OMA1 concentrations ranged from 0.1 to 0.4 ppm for the treatment and from 0.1 to 0.5 ppm for the control. The mean concentration at 1 h was less in the treatment (0.1 ppm) than in the control (0.3 ppm) ($p < 0.05$). This effect of treatment on speciation was not apparent after the 1 h sampling period.

This field study and a greenhouse study were used to test for effects of precipitation pH on the bioavailability of soil Al. Red spruce seedlings were planted in the field plots and received the artificial precipitation treatments. A second group of red spruce seedlings were potted in organic soil from the field site and were treated in the greenhouse with artificial precipitation of either pH 3.5, 4.1, or 5.0. At the end of eight months of treatment, needle tissue from the greenhouse seedlings was analyzed for Al. There was no statistically significant difference in Al concentrations among treatments with mean concentrations (n = 10) of 38 ppm, 53 ppm, and 55 ppm in seedlings treated with pH 3.5, 4.1, and 5.0 artificial precipitation, respectively. Needle tissue from field plot seedlings have not been analyzed yet.

In summary, the pH 3.5 treatment had no effect on Al chemistry during the May sampling period. During the October sampling period, it produced a short-term (< 1 d) alteration in Al speciation; slightly higher concentrations of TMAI at 1 h and 1 d; and lower concentrations of TMAI at 3 and 6 d. Spruce seedlings that received this treatment in the greenhouse had slightly lower needle concentrations of Al than those which received the pH 4.1 and 5.0 treatments.

This research was sponsored by the National Park Service, U.S. Department of the Interior, under Interagency Agreement NPS 0492-082-2 (DOE 40-1249-82) with Martin Marietta Energy Systems, Inc., under Contract No. DE-AC05-84OR21400 with the U.S. Department of Energy.

SPECIAL SESSION

Strategy to Conduct an Ecological Assessment of the Southern Appalachian Biosphere Reserve Cluster

May 22, 1986 - 1:00-3:00 p.m.

Discussion Leader - John Peine

Invited Panel Members:

University of Tennessee

John New
Frank McCormick
Mike Pelton
Richard Strange
Jim Tanner
Dave Lietzke

Oak Ridge National Laboratory

Bob Van Hook
Dale Johnson
Steve Lindberg
Sandy McLaughlin
Jerry Ellwood

University of North Carolina

Alan Stiven
Richard Bruce

Coweeta Hydrologic Laboratory

Jack Waide

Tennessee Valley Authority

Harvey Olem
Tim Crawford

National Park Service

Bill Gregg
Chuck Parker
Peter White

Tom Gilbert

The three reserves in the Southern Appalachian Biosphere Reserve Cluster include Great Smoky Mountains National Park Biosphere Reserve, Coweeta Hydrologic Laboratory Biosphere Reserve, and Oak Ridge National Environmental Research Park Biosphere Reserve. The underlying motivation for this discussion was to explore the potential value of a synthesis of research findings from the three sites. The consensus of the group was that a synthesis of research could prove very valuable if it were topical. Focusing on air pollutant deposition in the region, for example, could pull together many data sets from which a broad picture could emerge. Greater insight into regional perspectives on the types of pollutants, their forms and degree of deposition, their geographic distribution, and sources would all be extremely useful to the regulatory process associated with the Clean Air Act.

No clear perspective surfaced at the meeting as to how to best proceed with such a process, but Jack Waide of Coweeta agreed to take the initiative to devise a program.

The final product could be a hard-cover publication focusing on several key issues.

PARAVITREA CLAPPI: A STATUS REPORT

--R. W. Van Devender and Amy Van Devender, Department of Biology, Appalachian State University, Boone, North Carolina 28607

Paravitrea clappi is a small (6 mm) burrowing snail in the strongly endemic family Zonitidae. This species' range is generally the areas in the Great Smoky Mountains National Park above 5000 feet (1500 m). It was discovered by J. H. Ferriss and George H. Clapp just before the turn of the century, when these two professional amateurs became so enamored of the Southern Appalachians and its small fauna that they spent their summers wandering the high peaks and ridges by mule. Their interest led Henry Pilsbury of the Philadelphia Academy of Natural sciences to compile his "Mollusca of the Great Smoky Mountains."

When Paravitrea clappi with its harsh, restricted environment was pointed out as a potentially threatened species, the Tennessee Heritage Program and the Endangered Species Office of the U.S. Fish and Wildlife Service sent us in to find out if it was still extant. We found the snail in good numbers at two places below the road to Clingmans Dome. It lives among the detritus in loose talus on steep slopes, 12-18 inches (30-45 cm) below the surface. We searched a variety of sites between Newfound Gap and Spence Field, but only found it in these rather modified habitats.

The snail, from our cursory searches, still lives much as Ferriss found it. Several size classes were found together, so recent reproduction has taken place. Little is known of its ecology or life history. Since it is a litter invertebrate (with a dependence on the scarce mineral calcium) living in the spruce-fir zone of the higher peaks, study of its ecology might provide some data to help piece together how acid rain and pollutant deposition are affecting these sensitive areas.

RECENT FINDINGS OF A POPULATION OF FEDERALLY-ENDANGERED MUSSELS, EPIOBLASMA FLORENTIAN WALKERI, VILLOSA TRABALIS

--Steve Bakaletz, Department of Biology, Tennessee Technological University, Cookeville, Tennessee 38505

During the winter of 1985-86, a survey was conducted on the Big South Fork National River and Recreation Area. The results of the survey indicated the middle portion of the Big South Fork of the Cumberland in the national area has a remnant population of mussels consisting of fourteen species -- two federally-endangered Epioblasma walkeri, Villosa trabalis. Also, two species proposed to be listed by the U. S. Fish and Wildlife Service were found: Alasmodonta atropurpurea and Pegias fabula. Four live females of E. walkeri were found and photographed, six live males plus 20 similar values from a muskrat midden were also found. No live V. trabalis were located, but two freshly opened animals were obtained from a muskrat midden. Two fresh dead values of A. atropurpurea were also found in the midden. Eight live P. fabula were photographed; most had good periostracums, and twenty empty values were collected from the midden.

EVOLUTIONARY AND BIOGEOGRAPHIC RELATIONSHIPS OF SOME APPALACHIAN PTEROSTICHUS SPECIES (COLEOPTERA: CARABIDAE: PTEROSTICHINI)

--Robert T. Allen, Entomology Department, University of Arkansas, Fayetteville, Arkansas 72701

The ground beetle genus Pterostichus contains a large number of North American species and genera, including Great Smoky Mountain endemics. Pterostichus live in a variety of habitats such as southern swamps, spruce-fir forests, arid regions of the west, the Canadian Boreal forest and the Tundra. North American Pterostichus species may be broadly separated into three geographic categories: an Eastern fauna; a Western fauna; and a transcontinental fauna. The author's studies during the past twenty years have considered the cladistic and geographical relationships of these faunas. Preliminary Cladograms of taxon and biogeographic relationships are presented for a number of species and higher taxa found in the southern Appalachians.

COMMUNICATING MAN AND THE BIOSPHERE CONCEPTS TO THE PUBLIC

--Gary W. Mullins and John D. Peine¹

The 1984 Conference on the Management of Biosphere Reserves discussed the importance of public education as a vehicle through which public support could be gained for the Man and the Biosphere Program (MAB). Gregg and Zube, in 1984, stated that the "purpose of public communications in biosphere reserves is to promote understanding of the interdependence between human beings and natural ecosystems." In essence, the MAB concept and the associated research about these areas must be packaged and marketed to the various publics to ensure that these publics understand, desire and support MAB concepts and goals.

Such efforts require coordination and focus. The Uplands Field Research Laboratory is working with others to provide that direction. Currently three projects are underway to better communicate MAB issues to the publics:

- Marketing MAB concepts to local communities.
- MAB concept module development for the Gatlinburg, Tennessee schools.
- Air quality: the 1988 NPS interpretive thrust.

"Marketing MAB concepts to local communities" is a joint effort between the Uplands Field Research Laboratory, the Ohio State University and Interpretation Central to develop a manual for such marketing and to field test that procedure. Concepts to be included are audience analysis, target marketing, concept development, media-message relationships, implementation and evaluation. The intent is to develop a pragmatic system for expanding traditional interpretive services in MAB areas to the wider community.

"MAB concept module development" is a joint project with the Gatlinburg schools, Uplands Field Research Laboratory and the Ohio State University to develop K-8 MAB

education modules for use in the Gatlinburg elementary schools. The modules will serve as models for the development of similar MAB educational packages at other MAB area schools.

The "1988 thrust of NPS interpretation" is to be air quality. Because of the extensive air quality work being conducted through the Uplands Field Research Laboratory and the interest in interpretation at the Laboratory, the NPS MAB office is coordinating initial planning with the Laboratory and the Ohio State University. Preliminary work has only begun, but the potential for expanding a current MAB issue, air quality, NPS-wide is present.

These three projects represent a small sampling of the potential market-oriented projects that teachers, interpreters, managers, research scientists and others working in MAB can become involved in. The need for scientifically correct data concerning ecological preserves such as MAB areas is evident in our society. Without such data, our society will have difficulty in making ecologically sound decisions.

¹The authors are, respectively, Associate Director, School of Natural Resources, Ohio State University and Director, Uplands Field Research Laboratory, National Park Service.

AN ASSESSMENT OF THE PARK VISITOR AT GREAT SMOKY MOUNTAINS NATIONAL PARK

--John D. Peine and James R. Renfro, Uplands Field Research Laboratory,
National Park Service, Gatlinburg, Tennessee 37738

In 1985, more people visited the Great Smoky Mountains National Park (GRSM) compared to any other year--over 9.3 million visits recorded. To sufficiently provide the public opportunities to recreate and to manage the resource base, the recreation resource manager needs information about the lifestyles, interests, and characteristics of the public that uses recreation facilities. A total of 1,978 personal interviews were conducted with visitors to GRSM during the summer and fall of 1985. The purpose of this study was to develop a picture of the people who visit GRSM. The focus was on characteristics of the visitors themselves and of the particular trip they spent in the park. The intent was to provide a demographic, economic, and behavioral portrait of the visiting public, establish a taxonomy of visitor use patterns, and to compare these findings to previous surveys conducted in 1975 and 1956 in GRSM. The information generated and gained by this research can be used directly in recreation management or as an input to further analysis.

USE IMPACTS ALONG THE APPALACHIAN TRAIL

- James R. Renfro, Uplands Field Research Laboratory, National Park Service, Gatlinburg, Tennessee 37738

The Appalachian Trail (AT) in Great Smoky Mountains National Park was inventoried to assess backcountry trail and campsite conditions during the summer of 1984. The AT was sampled at 0.5-kilometer intervals. Location and condition of all severe impacts and potential maintenance problems were recorded. At each sample point, several factors were recorded such as slope, elevation, vegetation type, soil type, soil infiltration rate, precipitation, amount of visitor use, total width of trail, and average depth of trail. The degree of impact was measured using a cross-sectional area loss index. All 13 shelters along the AT were also surveyed as to physical impacts.

The quantity of trail impact on the AT in GRSM, measured by cross-sectional area loss, was related to soil type, vegetation type, precipitation, and trail slope. Impacts were generally highest in the spruce-fir forest type and on sandy loam soils. Site factors, including soil information, were not found to be useful in predicting the location or intensity of future impacts. Analysis of variance showed significant differences between vegetation types and cross-sectional area loss and between soil types and cross-sectional area loss.

At the campsites, the amount of trash and human waste is quite noticeable and substantial. Amount of bare soil has decreased since 1977 and amount of bare soil was not related to amount of visitor use.

WILDLIFE-RELATED PERCEPTIONS OF VISITORS IN CADES COVE, GREAT SMOKY MOUNTAINS NATIONAL PARK

- Bruce C. Hastings and William E. Hammitt, Department of Forestry, Wildlife and Fisheries, University of Tennessee, Knoxville, Tennessee

Wildlife viewing has become a popular recreational pursuit in the United States. However, little has been documented about visitor perceptions of wildlife at specific locations. An ideal site for conducting such a study was the Cades Cove region of Great Smoky Mountains National Park. Wildlife were abundant and often visible in Cades Cove, resulting in many positive human-wildlife interactions.

A total of 400 visitors were interviewed in their vehicles at the end of an 18-km, one-way road through the Cove. Sampling was conducted during July and August of 1983. Participants were asked to take a 10-page questionnaire home to be completed at a more convenient time. The mail return rate for completed questionnaires was 85%.

The opportunity to view wildlife was a very important factor in visitation of Cades Cove; 92.3% of the respondents noted wildlife viewing as a reason for their trip to Cades Cove. More than half (58.1%) left their vehicles specifically to observe wildlife, and 56.1% also photographed them.

At least 38 species of wildlife were observed by visitors, the most common being white-tailed deer (91.0%). Other commonly reported animals included crows (70.8%), ground hogs (51.5%), black bears (29.3%), gray squirrels (28.8%), wild turkeys (19.3%)

and "other birds" (28.8%). Animals commonly seen outside the park or not immediately perceived as wildlife (e.g., crows, squirrels, songbirds) were often not reported until visitors were shown a list of wildlife.

Rankings of visitor preferences and expectations for viewing wildlife, and actual observations of wildlife were all correlated with each other (range of tau = .63 - .75). Participants who were interviewed in their cars expected to see white-tailed deer more than other species, but stated a preference for bears. The most preferred animals reported by questionnaire respondents were deer, bears, turkeys, eagles, and raccoons, respectively. The least popular animals included snakes, bats and lizards. Preferred groups of animals were often aesthetic or important culturally or historically. Commonly feared and domestic animals were least preferred.

Analysis of attitudes toward specific management issues demonstrated that: (1) most people would not object to markers on deer, particularly if the reason for the markers' existence was explained by the NPS and/or the color of the markers blended with the pelage color; (2) most people supported reintroduction of some animals (e.g., elk, river otters, undomesticated bison, and peregrine falcons), while being less enthusiastic toward re-establishment of wolves and mountain lions; (3) although exotic species such as wild hogs and coyotes were not preferred animals for viewing, they were not as universally rejected by the public as the Park Service might prefer; and (4) more people supported the present NPS management of overpopulated deer (i.e., transport out of the park for populating other areas for eventual hunting) than any other alternative. Additional analysis demonstrated that attitudes were not highly influenced by current NPS wildlife information, that a wildlife brochure should be developed specifically for Cades Cove, and that all information sources should try to improve attitudes toward wildlife and wildlife management as well as provide knowledge.

In general, visitors were not very knowledgeable in any of six areas of wildlife and wildlife management (range = 44.6% - 58.2% correct answers). The most influential variables associated with knowledge were time of day when viewing took place and educational background. Visitor age, hunting orientation, and type of area where the respondent grew up were not related to any knowledge index. Reading the park wildlife brochure also appeared ineffective in significantly increasing knowledge for the items investigated. Knowledge was, at best, weakly correlated with attitudes toward wildlife and wildlife management.

Existing data on the wildlife resource in Cades Cove were integrated with information generated by this study about visitor preferences and needs for wildlife in order to develop wildlife viewing programs. The major questions of visitors (e.g., when and where to see different species) were answered using results of past research in Cades Cove on such animals as bear, deer, raccoon, ground hog and skunk. Numerous alternatives for providing wildlife viewing opportunities were also outlined from integrating results of this survey with a review of the literature on management and interpretation of wildlife. The most notable recommendations for Cades Cove included providing more wildlife habitat along streams and fences, subdividing some fields, developing two short wildlife loop trails and three quiet walkways, adding a few paved pull-offs in key wildlife viewing areas to avoid traffic jams, and increasing emphasis on wildlife in the interpretation of Cades Cove.

A theoretical model was proposed to explain how various factors may be influencing how people think and act toward wildlife. While this survey was not designed to test the model, the theoretical framework may be useful in understanding some of the results and providing guidance for future research.

USE OF IMPORTANCE-PERFORMANCE ANALYSIS IN EVALUATION AND MANAGEMENT OF ELKMONT CAMPGROUND IN GREAT SMOKY MOUNTAINS NATIONAL PARK

--Susan J. Wallace, Joseph T. O'Leary, F. Dominic Dottavio and John D. Peine¹

Retailers and campground managers provide products and services in an attempt to satisfy consumer needs. The "product" being offered by the campground manager is a high quality recreation experience. Since quality is intangible and cannot be managed directly, those concrete factors influencing quality must be identified and managed. However, most campground evaluation studies to date have looked only at visitor satisfaction. Little information exists as to which campground features are considered by campers to be important. The purpose of this study was to test the applicability to campground management of a marketing evaluation technique known as importance-performance analysis, or the Action Grid approach.

This procedure involves the identification of important campground attributes, a survey of visitors, calculation of importance and performance (satisfaction) ratings for each attribute, and construction of a graph or Action Grid plotting importance values versus performance values. This method of evaluation was applied in the Elkmont campground at Great Smoky Mountains National Park during the summer of 1984. Questionnaires used in this study requested response to the importance of and satisfaction with campground features, visitor group structure, origin of the trip, and visitor characteristics. Several open-ended questions were also included. Data analysis was completed using both specialized microcomputer programs and the Statistical Package for the Social Sciences (SPSS).

Action Grids for the campground indicate that managers are doing a good job. The qualitative data supplied by the open-ended questions served to enhance sensitivity to visitors' perceptions and pointed out areas in need of improvement. Importance-performance analysis was found to be quite applicable in the area of campground evaluation because it: (a) points out both strengths and weaknesses, (b) presents the results in an easily-understood form, (c) provides an excellent communications and public relations tool, and (d) can be instrumental in the development of a list of important attributes. Such a list can be a valuable tool to a campground manager.

¹ Authors are, respectively: Graduate Research Assistant; Associate Professor, Department of Forestry and Natural Resources, Purdue University, W. Lafayette, IN 47907; Director, National Park Service Cooperative Park Studies Unit, Clemson University, Clemson, SC 29634-1005; Director, Uplands Field Research Laboratory, Great Smoky Mountains National Park, Gatlinburg, TN 37738.

USE OF IMPORTANCE-PERFORMANCE ANALYSIS IN EVALUATION OF THE SUGARLANDS VISITOR CENTER, GREAT SMOKY MOUNTAINS NATIONAL PARK

--Kathy King Mengak, F. Dominic Dottavio, Joseph T. O'Leary and John D. Peine¹

Each year, millions of people stop at the many visitor or interpretive centers scattered throughout the country. Unfortunately, few methods exist to evaluate the effectiveness of these centers. This study used a marketing strategy called Importance-Performance Analysis to evaluate visitors' perceptions of the operation of the Sugarlands Visitor Center located in Great Smoky Mountains National Park. Use of this technique first involved developing an attribute list that accurately described the visitor center. Next, a mail-back questionnaire was developed using these attributes in an idealized setting and performance of those same attributes in the actual setting. Information regarding the visitor's activities while at the visitor center and sociodemographic information were also collected. Slightly over 68 percent of the participants returned their mail-back questionnaires. Results were graphically displayed on an easily interpreted, two-dimensional "action grid." The grid plotted mean values for importance and performance into one of four quadrants. Park visitors were found to be generally satisfied with the services and facilities provided. Visitors seemed particularly pleased with the convenient location of the center, the accessibility of park maps, the friendly interpretive personnel, and the exhibit area. Visitors did indicate, however, that cleanliness and availability of supplies in the restrooms and the explanation of the historical features in the exhibit area could be improved. This evaluation tool proved to be useful for identifying strengths and weaknesses as perceived by park visitors at the visitor center.

¹ Authors are, respectively: Research Associate; Director, National Park Service Cooperative Park Studies Unit, Clemson University, Clemson, SC 29634-1005; Associate Professor, Department of Forestry and Natural Resources, Purdue University, W. Lafayette, IN 47907; Director, Uplands Fields Research Laboratory, Great Smoky Mountains National Park, Gatlinburg, TN 37738.

ASSESSMENT OF INTERPRETIVE SERVICES: AN EXAMPLE FROM THE ROARING FORK MOTOR TRAIL IN THE GREAT SMOKY MOUNTAINS NATIONAL PARK

--Kathy King Mengak, F. Dominic Dottavio, Joseph T. O'Leary and John D. Peine¹

According to Stephen W. Sears (1977:7), "no other single instrument of twentieth century technology has affected more lives more profoundly than the automobile." Within a relatively short period of time, the automobile became an "instrument for a people with much space and little time" (Sears 1977:7, quoting Boorstin). One outcome of this "love affair" with our cars has been the self-guiding auto tour. These tours allowed people to view natural and cultural resources from the comfort of their own cars. Unfortunately, few methods exist to evaluate how well this interpretive medium is meeting our mobile society's needs. One potentially useful means of evaluation is a marketing strategy called Importance-Performance Analysis. This evaluation technique identifies important features or attributes that describe the subject of the study, in this case the Roaring Fork Motor Nature Trail in Great Smoky Mountains National Park. Once these attributes were identified, park visitors to the site were questioned in a

mail-back survey as to their feelings regarding an attribute's importance in an ideal situation and performance in the real setting. Information regarding the visitors' activities while on the auto tour and sociodemographic information were also collected. A 77 percent return rate was obtained. Results were graphically displayed on easily interpreted, two-dimensional "action grids." These grids illustrated the auto tour's strengths and weaknesses by placing each evaluated attribute into one of four quadrants. Examination of these grids revealed that park visitors were largely satisfied with the interpretive services and facilities provided. Park visitors viewed the strengths of the Roaring Fork Motor Nature Trail as the scenic views along the route, the opportunities for peace and quiet, and the appreciation of the area gained from the auto tour. Inadequate signage, limited parking spaces, and lack of restroom facilities constitute the major shortcomings cited by park visitors. Armed with these visitor perceived strengths and weaknesses, managers can make necessary changes and improvements in the interpretive system.

¹ Authors are, respectively, Research Associate; Director, National Park Service Cooperative Park Studies Unit, Clemson University, Clemson, SC 29634-1005; Associate Professor, Department of Forestry and Natural Resources, Purdue University, W. Lafayette, IN 47907; Director, Uplands Field Research Laboratory, Great Smoky Mountains National Park, Gatlinburg, TN 37738.

VERTICAL AND ASPECTUAL DISTRIBUTION OF EPIPHYTIC BRYOPHYTES ON YELLOW BUCKEYE

--G. S. Huntzinger and D. K. Smith, Department of Botany, University of Tennessee, Knoxville, Tennessee 37996-1100

Epiphytic bryophytes were intensively sampled on 13 yellow buckeyes (Aesculus octandra Marsh.) located in a cove hardwood forest in the Great Smoky Mountains National Park. Cover and frequency values for the epiphytes were obtained with the use of a 14 x 14 cm quadrat.

The four cardinal compass points (north, east, south, and west) were sampled by four vertical transects centered on these exposures of the phorophyte. The transects extended from the tree base upward to a height of 1.5 m. At each of the four compass points, the width of the vertical transect was defined by the distance circumscribed by a 20° arc of the tree's circumference, with the center of the arc located at the compass point.

The vertical distribution of the epiphytes on each of the four aspects sampled was examined using ordination (DECORANA) and classification (TWINSPAN) techniques. These two complementary approaches revealed the presence of distinct vertical distribution patterns among the epiphytes. Thamnobryum alleghaniense, Anomodon rugelii, Metzgeria conjugata, Burhynchium hians, and Thuidium delicatulum occurred in the lower region of the transects while Brachythecium oxycladon occurred in the lower and middle regions but was most abundant in the lower region. Anomodon attenuatus and Anomodon rostratus were ubiquitous species on all four aspects. Radula obconica, Anomodon minor, and Lejeunea ulicina were present in low cover in the middle region

of the transects. Cololejeunea biddlecomiae occurred sporadically throughout the transects on each of the four aspects. Forsstoemia trichomitria, Frullania brittoniae, Porella platyphylloidea, Radula complanata, Schwetschkeopsis fabronia, Neckera pennata, Homalotheciella subcapillata, Haplohymenium triste, and Dicranum viride were present in the upper and middle regions of the transects. Ulotia crispa, Amblystegium varium, Leucodon julaceus, and Frullania eboracensis were restricted to the upper region of the transects.

The information generated on the vertical distribution patterns of epiphytes by ordination and classification techniques demonstrated that the aspectual effect was most pronounced on the south aspect, presumed to be due to the presence of drier microclimatic conditions. Species occurring in the upper and middle regions of the transects on the north, east, and west aspects extended further down the transects on the south aspect, possibly the result of a reduction in competition with other species, primarily the ubiquitous Anomodon attenuatus and Anomodon rostratus. The cover of many of the epiphytes on the south aspect was also considerably reduced as compared to the other three aspects.

A comparison of means (i.e., mean cover/tree/aspect) showed that the north, east, and west aspects were not significantly different from each other, yet all had significantly greater cover than the south aspect. Coefficients of community, calculated for all possible two-aspect combinations, also revealed that the north, east, and west aspects were more similar to each other than they were to the south aspect.

EFFECTS OF GYPSY MOTH DEFOLIATION ON FOREST COMPOSITION IN SHENANDOAH NATIONAL PARK

--Steve McConnell and Tom Nichols, Department of Forestry, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061

--John Karish, National Park Service, University Park, Pennsylvania 16802

Gypsy moth (Lymantria dispar L.) defoliation is expected to occur in Shenandoah National Park (SNP) for the first time this year (1986) as the main front of the natural spread of the gypsy moth (GM) in North America extends southward. Much of SNP's forest community is in the upland oaks hardwood type, which is identified as highly susceptible to GM defoliation. It is likely that most of SNP will be infested by the GM in 5 to 7 years. Short-term effects of GM defoliation include impairment of visitor enjoyment because of the nuisance problem created by larvae and effects to aesthetic qualities resulting from defoliation of trees. Longer-term effects include a change in forest tree species composition and wildlife occurrence. GM-induced mortality will alter stand structure immediately. Regeneration of the favored oaks (Quercus sp.) may be reduced by decreased acorn production and decreased litter accumulation. This may lead to a concomitant increase in non-favored GM host species. Wildlife may also be affected by decreased acorn production.

This study is being conducted in two parts: (1) immediate acorn production and regeneration effects, and (2) stand composition. The acorn production and regeneration phase began in 1985 (expected to be completed by spring 1987), and entails a study of litter production, accumulation and decomposition, germination and early survival of

host and non-host species under field conditions, as well as the quality and quantity of acorn production. Plots are located in (1) stands already defoliated and expected to be defoliated again, (2) stands not defoliated but expected to be defoliated, and (3) stands not expected to be defoliated during the study. Half of the stands are located in SNP, while others are located out of the park in northern Virginia and Maryland.

The second part of the study includes the establishment of a long-term ecological monitoring system for the terrestrial vegetation in the park. Much of this project will entail development of the system, rather than plot establishment. Considerable plot data should be collected during development of the system, however, enabling comparisons in many stands. This plot system project is part of a cooperative effort between wildlife, entomological, and stream fauna specialists in a multi-discipline monitoring system.

PRESCRIBED BURNING AND VEGETATION MANAGEMENT ON THE BLUE RIDGE PARKWAY

--A. M. Wilson, S. M. Zedaker and O. F. Hall, Virginia Polytechnic Institute and State University, Blacksburg, Virginia

Vista clearing is an important aspect of management on the Blue Ridge Parkway. A program of prescribed burning, as an alternative to land clearing, is described. Vegetation inventories are conducted every summer to determine species, number of root crowns and height growth in three classes: greater than three meters, one to three meters, and less than one meter. Prescribed burning in the fall and spring is planned. Attempts will be made to correlate fire intensity with reduction in height and changes in species composition/frequency. Also depth of char will be measured to determine its suitability as a post-burn indicator of fire intensity.

Fire behavior measurements will be taken at each unit to determine the fire intensity. Rate of spread will be measured by a non-directional sampling technique developed by Simard in 1982. A five-point grid will be set in each unit for time measures and flame length estimation. These are the components of fire intensity. Depth of char will be measured post-burn by removing char from the root collar. An economic analysis will be conducted on a yearly basis.

First year results on fall burning indicate that burning reduces species height but stimulates sprouting in the smaller height classes. The area of greatest concern is the greater than three meters class that most restricts the scenic overlooks. This class showed an overall decrease of 77% in the total number of stems while the remaining classes showed slight increases. The preliminary economic analysis based on the units successfully burned indicates that burning is a cost-effective method of clearing. The average cost of burning was \$56 less per acre. The duration of the fire effects, particularly the reduction in height growth, will be determined as the study continues.

RELATIONSHIPS BETWEEN SITE AND STAND CHARACTERISTICS OF SOUTHERN APPALACHIAN SPRUCE-FIR

--N. S. Nicholas and S. M. Zedaker, Department of Forestry, Virginia Polytechnic Institute and State University, Blacksburg, Virginia

C. C. Eagar, Uplands Field Research Laboratory, National Park Service, Gatlinburg, Tennessee

P. S. White, National Park Service Cooperative Park Studies Unit, University of Tennessee, Knoxville, Tennessee

A five-year study is being carried out on three sites (Mount Rogers/Whitetop, Virginia; Black Mountains, North Carolina; Great Smoky Mountains, Tennessee and North Carolina) to examine possible decline and regeneration of southern Appalachian spruce-fir. With one year of study completed, randomly located long-term permanent plots have been sampled, with stratification variables at each site including elevation, exposure to prevailing winds, and slope position.

Before being able to analyze any change in the forest system, first we identify the structure and composition of stands at the starting point of the study. TWINSPAN (Two-way indicator species analysis), a hierarchical classification technique, was used with live basal area as input and four forest types were derived: spruce, spruce-birch, spruce-birch-fir, and fir-spruce. The precision of the forest type groupings was examined by ordination analysis using DECORANA (detrended correspondence analysis). The first two ordination axes accounted for most of the variation of species distribution. The ordination axes were then examined for environmental significance by linear correlation and regression techniques. Variation of species distribution on the primary axis was best explained by a combination of elevation and slope percent.

TECHNIQUES FOR PRESERVING AN ENDANGERED ALPINE PLANT (POTENTILLA ROBBINSIANA) IN THE WHITE MOUNTAIN NATIONAL FOREST: A CASE STUDY

--Kenneth D. Kimball, Research Department, Appalachian Mountain Club, Gorham, New Hampshire 03581

Potentilla robbinsiana is a small, flowering alpine plant believed to be endemic to only 2 locations in the White Mountains, New Hampshire. It is listed as a federally endangered species. The current management program has three phases: an autecological and demographic study on the species, an effort to minimize the impact of botanists, naturalists and hikers on the species, and the development of four new colonies through the use of transplants.

The population is comprised of approximately 1800 adult-sized plants in a one-hectare field on Mt. Monroe and 6+ established plants on a craggy area region some 32 km SW. The plant appears to be restricted to relatively barren alpine habitats with a southerly aspect and windswept of snow. Sites with all of these features are not common in the White Mountains. Ongoing demographic studies suggest no major decline in the species is occurring. The breeding biology of P. robbinsiana suggests that the plant is apomictic

and pseudogamous, even though it has a complete flower and reproduces by seed. Isozyme work will be done in 1986 to determine the genetic diversity of the species. New populations will be established with transplants grown from seeds in a greenhouse once the genetic diversity is understood.

The management plan has evolved around the heavy hiker traffic in the immediate vicinity of the primary habitat, and pressure put on the species by collections for herbariums. The latter is now illegal. In 1979, one of two hiker trails in the plant's habitat was diverted, and the second was defined for its entire length with an unobtrusive scree wall. A "stay on the trail" education program for hikers was started by the Appalachian Mountain Club. In 1983, the second trail was diverted out of essential habitat, a scree wall built to define the plant's essential habitat, and the habitat legally closed to the public. Hiker trespass counts suggest that the scree wall used to define the entire hiker trail in the habitat was as effective as the trail diversion in preventing hiker trespass. U.S. Forest Service signs used in 1984, which cited possible fines (\$500) and imprisonment (6 months), irritated the general public. To enlist continued public cooperation, these signs were altered to a style of general notification that the essential habitat was closed due to an endangered plant. No increase in hiker trespass followed and the hiker public has been very cooperative in staying out of the essential habitat. The hiker education program contributed to this success.

AN ASSESSMENT OF THE SPRUCE-FIR FORESTS IN THE SOUTHERN APPALACHIANS

--Elizabeth S. Groton, Forest Resources Development Program, Tennessee Valley Authority, Norris, Tennessee 37828

In the fall of 1984, the Tennessee Valley Authority (TVA) initiated a project to survey the condition of the spruce-fir forests within the Tennessee Valley region with regard to possible declines caused by atmospheric deposition. The primary objectives of this project included a characterization of the spruce-fir population, a description of possible decline symptoms and their extent, and the establishment of baseline data with which to monitor future changes.

This research utilizes a system of permanently located forest inventory plots; 10 existing plots were remeasured and 38 additional plots were established. Plots were located throughout the region excluding the GSMNP because of similar ongoing research. Results of the analysis of the data collected in the survey indicates that the spruce-fir is an extremely variable population in terms of the usual descriptors. Eleven of the forty-eight plots were determined to be undisturbed by any major catastrophe. Discriminant analysis indicates that there are differences in stand parameters according to site history.

Regeneration ranged from none to extremely dense. Only one high elevation plot (6,000') had no small (< 1') regeneration; this plot did have large regeneration.

Mortality was extremely high in areas impacted by the balsam woolly adelgid. The major causes of spruce mortality were weather and suppression.

Low crown vigor classes were found in plots showing a great deal of wind damage. Six plots in the Black Mountains had trees of vigor class 3 (more than 50 percent damaged). Of these six, four were undisturbed plots with large percentages of old trees. Five of the six were high elevation (> 6,000') and had southwest aspects.

A number of regression analyses were done with generally poor results due to the small sample size. The only model for which elevation showed a statistically significant partial sum of squares was for current basal area. A regression analysis on the sum of annual radial increment for 1960-1984 indicated that the age of overstory trees and the amount of disease present in the stand made significant contributions.

Other possible decline symptoms were noted. The most prevalent included a foliar necrosis on small red spruce (apparent at 27 of the 48 plots) and damaged terminal buds (30 plots).

A collaborative effort by TVA, USFS, and NPS has been undertaken for dendroecological analysis of tree increment cores collected by TVA and NPS. Five independent statisticians are analyzing these data to determine if changes in growth trends are apparent. Results of these analyses will be made public this summer.

REMOTE SENSING OF VEGETATION PATTERNS IN GREAT SMOKY MOUNTAINS NATIONAL PARK

--Peter S. White and Mark MacKenzie, National Park Service Cooperative Park Studies Unit, University of Tennessee, Knoxville, Tennessee

John Rehder, Geography Department, University of Tennessee, Knoxville, Tennessee

A vegetation mapping project using 13-m resolution, aircraft-collected, multi-spectral scanner data was initiated in Great Smoky Mountains National Park in 1982. A number of technological problems were encountered by the NPS Remote Sensing Branch (Denver Service Center) in processing these data. The most severe problems proved to be geographic referencing and combining data from different flight lines and seasons into a single data base. In 1985, we elected to move the project to the new ERDAS system at the University of Tennessee, using a grant from the NPS Washington Office. We were also able to obtain 80-m and 30-m resolution, satellite-collected data. Progress to date (Spring, 1986) includes mapping of spruce-fir forests (including several subtypes) and intensive work on the Mt. LeConte and Mt. Guyot areas from a variety of remotely sensed imagery.

UTILIZATION OF REMOTELY-SENSED DATA ANALYZED BY A GEOGRAPHIC SYSTEM TO EVALUATE SPRUCE-FIR MORTALITY

--C. W. Dull and J. D. Ward, Forest Pest Management, USDA Forest Service, Atlanta, Georgia

The USDA Forest Service, Forest Pest Management Staff, has been involved with evaluating the conditions of the spruce-fir forests in the Southeast Appalachians for the past twenty years. These activities revolved primarily around suppression and evaluation of balsam woolly adelgid populations. However, recent concerns over the effects of atmospheric deposition has initiated research projects to determine the present condition of spruce-fir in the Southern Appalachians. Forest Pest Management has undertaken a project to determine the extent of spruce-fir mortality in the southeast. Color infra-red aerial photography at a scale of 1:12000 was acquired during the summer growing season (leaf on) and true color aerial photography at a scale of 1:12000 was acquired during the winter season (leaf off) to provide baseline data to delineate the boundaries of the spruce-fir forest type and to determine the amount of tree mortality within those boundaries. The aerial photography was interpreted with the results transferred to USGS 7 1/2-minute series topo sheets. Within the spruce-fir type boundaries, areas of severe mortality (greater than 70%), moderate to heavy (30-70%), low mortality (less than 30%), and down timber were determined. Spruce-fir type boundaries and the mortality stratifications covered an area over 24 quad sheets.

This data was then digitized using the analytical mapping system (AMS) and then analyzed by a Geographic Information System, Map Overlay and Statistical System (MOSS). Maps were then produced from these data using the Cartographic Output System (COS). These three software packages comprise the MOSS family of software. Sample plots were randomly selected on the aerial photographs for individual tree counts over a one-tenth acre area, from which a sub-sample was ground-checked to validate the photo interpretation. Additional data themes, such as topography, transportation networks, aerial photo centers, study plot locations, ownership boundaries, disturbance history information and drainage patterns were included in the geographic data base. Additional data themes will be included as information becomes available.

A Geographic Information System enables the users of this data base to evaluate spacial data in reference to each other within a geographic area. Overlays of one data base on another can be conducted to determine the areas of intersection and union to answer questions of concern to resource managers. Typical scenarios may be: what would be the area of the spruce-fir forests above a given elevation, the perimeter of a spruce-fir forest around a given mountain, the most direct means of transportation from one point to another, or to determine aspect and slope off a given geographic area. A wide variety of information can now be obtained through the automated analysis and interactive display by computer as a result of the development of this data base. Of primary interest will be the determination of the number of acres of spruce-fir mortality for each of the primary geophysical areas within the southeast. Utilization of this data base by research cooperators is encouraged and mapped data concerning the spruce-fir resources would be appreciated for inclusion into this data base.

DETERMINANTS OF LANDSCAPE PATTERN IN A HETEROGENEOUS ENVIRONMENT

--R. H. Gardner and V. H. Dale, Environmental Sciences Division¹, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831

P. S. White, National Park Service Cooperative Park Studies Unit, University of Tennessee, Knoxville, Tennessee

The prediction of large-scale changes in vegetation pattern requires topographically-based information on climate, geology, major ecosystem processes, and disturbance history. We propose to determine the significance of each of these variables on vegetation pattern in disturbed and undisturbed systems in the Great Smoky Mountains National Park. The Great Smoky Mountains is ideal for landscape studies because of its biotic diversity, topographic heterogeneity, documented disturbance history, and extensive data on relevant abiotic and biotic features. The identification of critical relationships will be accomplished by (1) analysis of existing data using a geographic information system, (2) spatially extensive field studies, and (3) ecosystem models that embody different theories on the role of ecosystem processes. Validation tests of our predictive ability will use site-specific and probabilistic comparison of simulation results against measurements of vegetation pattern. This identification of the significant spatial determinants of vegetation pattern is a key prerequisite for the development of a landscape paradigm.

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PRE-PARK DISTURBANCE AS A FACTOR IN THE LANDSCAPE OF THE WESTERN SMOKIES

--Charlotte Pyle, Department of Forestry, Wildlife and Fisheries, University of Tennessee, Knoxville, Tennessee 37996

The study area encompassed a 41,000-hectare tract generally comprised of that portion of Great Smoky Mountains National Park (GRSM) located in Tennessee, west of Cades Cove and south of Abrams Creek. A previous investigation was made by the present author and C. D. McCarter for the purpose of locating field evidence of the type and extent of pre-park disturbance in the area. Using a portion of the results of that investigation in conjunction with aerial photographs and a vegetation map made by Frank H. Miller, I examined the relationship of patterns in the current landscape to the land use pattern prior to 1940. Two major disturbance patch landscape elements were defined. Previously farmed disturbance patches dominated by yellow-poplar (Liriodendron tulipifera L.) were found almost invariably along historic travel corridors. Yellow pine (Pinus L. spp.) dominated patches, attributed to the influence of repeated fire, were generally found on ridges. Although characterized as macro-homogeneous, the landscape also exhibited micro-heterogeneity in the distribution of

yellow pines versus hardwoods. Examination of Miller's pre-1940 yellow pine-hardwoods vegetation boundaries and aerial photographs dated 1925 and 1982 provided evidence that the change in disturbance regime (from frequent fire to fire suppression) influenced the size and density of yellow pine trees within individual pine patches. The silvics of yellow pine, the potential behavior of fire in micro-heterogeneous topography, and spatial linkages were discussed. A list of implications for park management policy at the landscape level was presented.

THE ECONOMIC BOTANY OF VASCULAR PLANTS FOUND IN SOUTHERN APPALACHIA

--Anita Bailey, Department of Biology, Tennessee Technological University, Cookeville, Tennessee 38505

A study to identify vascular plants that have or have had economic uses was undertaken for the southern Appalachian region. Potential uses were also included. Specific categories considered included: food, medicinal, poisonous, ornamental, chemical product, building material, and fiber plants, as well as a miscellaneous category. This information was collected for use in interpretive and resource management programs in the Great Smoky Mountains National Park and for use by the National Park Service as a whole in developing a new dimension to the conservation ethic, that of the national parks as economically valuable gene reservoirs.

A data sheet was developed for the collection of information and was used in an extensive literature survey. This resulted in the identification of 1,151 useful individual species, with 141 additional entries at the genus level.

PRESCRIBED BURNING FOR HARDWOOD CONTROL AND FUEL REDUCTION ON THE CUMBERLAND PLATEAU

--Michael T. York and Edward R. Buckner, Department of Forestry, Wildlife and Fisheries, University of Tennessee, Knoxville, Tennessee

Over the past two decades, many low quality upland hardwood stands on the Cumberland Plateau have been converted to loblolly pine (*Pinus taeda* L.) plantations. A U.S. Forest Service forest survey suggests that pine will be more productive than the native hardwoods on these sites. Loblolly pine has been planted because it grows faster than the pines native to the Cumberland Plateau.

Despite chemical and mechanical measures for hardwood control, aggressive hardwood competition has reduced pine stocking and growth in most loblolly plantations. Older, well-stocked plantations with heavy roughs are continually endangered by wildfire. A safe and effective means for controlling hardwoods and reducing dangerous fuel levels is needed if pine plantation management is to be feasible on the Cumberland Plateau. Prescribed fire has been used with much success to control understory hardwoods and reduce fuels on the flat terrain of the Coastal Plain. Prescribed fire might also be an effective pine management tool on the Cumberland Plateau if safe burning techniques can be developed for the rolling, hilly terrain characteristic of this region.

To study prescribed fire on the sloping terrain of the Cumberland Plateau, 12 burns were conducted in a 26-year-old loblolly pine plantation on an east-west oriented ridge. The burns took place during the fall of 1979 and the spring and summer of 1980. Four burns were conducted in a single day during each season, 2 on the south-facing and 2 on the north-facing slope. The burns were ignited in anticipation that a regional wind pattern would control where fires burned as headfires or backfires (i.e., where a fire was ignited at the base of one slope to burn as an upslope headfire, the headfire on the opposite slope would be ignited at the top of the ridge to burn downslope).

The lowest relative humidity and fuel moisture was recorded on the day of the spring burns. The spring burns were the most intense of the seasonal tests; they killed more understory hardwoods and consumed more surface fuel. However, they killed twice as many pine crop trees (22%) as the fall burns and 3 times more than the spring burns.

Regional windspeeds were low on the 3 burn days; wind movement was most strongly influenced by topography. Downslope fires behaved as backfires (fires burning against the wind) whereas upslope fires behaved as headfires (fires driven by the wind). Upslope and downslope fires were equally effective for hardwood control and fuel reduction. The mean spread rate for the 6 upslope fires was 212 feet per hour and the mean spread rate for the 6 downslope fires was 66 feet per hour. Although the upslope fires were fast-moving, they killed 17% of the loblolly pine crop trees. The downslope fires killed only 9% of the loblolly pine crop trees, mostly in the small diameter classes. The disadvantage of the downslope fires was that they moved too slowly to be practical or economical to use on a large scale.

VEGETATION PATTERNS AND ENVIRONMENTAL FACTORS IN THE BLACK AND CRAGGY MOUNTAINS, NORTH CAROLINA

--Don McLeod, Department of Biology, Mars Hill College, Mars Hill, North Carolina 28754

As a part of a floristic and vegetation study of the Black and Craggy Mountains of North Carolina, I sampled the vascular plants with an estimation of cover-abundance in 156 0.1-ha plots. Multivariate analysis techniques were used to classify and ordinate this data set and to correlate vegetation with environmental factors.

Sixteen vegetation types were recognized: cove forest, alluvial forest, eastern hemlock-mesic forest, eastern hemlock forest, oak-mesic forest, oak-hickory forest, red oak forest, chestnut oak forest, scarlet oak forest, Carolina hemlock forest, xeric oak-pine forest, beech-yellow birch forest, spruce forest, fir forest, heath balds and meadows.

The primary ordination shows strong correlation with elevation on the vertical axis and with soil nutrients and solar beam irradiation on the horizontal axis. Subsequent ordinations reveal strong correlations of the vegetation below 1524 m (5000 ft) with soil nutrients, aspect, slope position, slope degree, solar irradiation and elevation. Correlations above 1524 m were strongest with pH, P, elevation, solar irradiation and aspect.

These results indicate that the composition of the vegetation of the area can be satisfactorily correlated with environmental variables, especially elevation, soil nutrients, pH and solar irradiation. Furthermore, sampling all vascular plants may lead to better results than sampling only arborescent vegetation.

RECLAIMING HIGHLY ACID SPOIL BANKS ON THE BIG SOUTH FORK

--Edward Buckner, Department of Forestry, Wildlife and Fisheries, University of Tennessee, Knoxville, Tennessee

Jack Muncy, Tennessee Valley Authority, Norris, Tennessee

Sam Kunkle, National Park Service, Water Resources Division, Fort Collins, Colorado

Mike Rikard, National Park Service, Clemson University, Clemson, South Carolina

In 1974 the Big South Fork National River and Recreation Area was established with the U.S. Army Corps of Engineers responsible for development and the National Park Service (NPS) responsible for administration. From the turn of the century until around 1960, this area was logged and extensively deep-mined for coal. Essentially all of the commercial timber was removed and mine tailings were dumped into the gorge from the many (120) underground entries that were generally dug from where coal seams were exposed along the canyon wall. These highly acid spoil banks were still essentially void of vegetation when reclamation activities were initiated in 1984. Their high visibility from the heavily-used recreational river made their reclamation a high priority.

A pilot study located previous reclamation work done along the river by the U.S. Forest Service and demonstrated that adequate pine seedling survival could be obtained, provided:

1. The spoil was left undisturbed as weathering at the spoil surface had ameliorated the low pH (2.3-2.8) and high conductivities (0.8 mmhos/cm) characteristic of the fresh spoil (which would be exposed by any spoil disturbance, e.g. grading);
2. Lime is applied at the rate of 6-7 tons per acre; and
3. A heavy straw mulch (secured against wind movement) is applied to prevent temperature build-up on the black, south-facing spoil surface.

Additional recommendations based on other studies, experience and the desire to build in a significant safety factor included:

1. Planting a seedling mixture composed of 1/3 loblolly pine, 1/3 Virginia pine and 1/3 black locust on a 6' x 6' spacing;
2. Using a slowly soluble fertilizer tablet (22-8-2) in the closing hole;
3. Dipping all seedling roots in a synthetic soil moisturizing slurry to help overcome the droughty site conditions; and
4. Broadcasting a mixture of hardwood tree seed into the straw mulch that would establish the secondary seral stage characteristic for this region.

These recommendations were implemented in the Spring of 1985 through a contract with TVA. After the first growing season, the results appear promising. Survival (generally above 75%) and early growth was good with uniform stocking of woody trees

over most of the spoil. Black locust made the best 1st year growth. Due to the spacing arrangement used it should not, however, shade out the more desirable pines that will provide better long-term site protection.

Another component of the reclamation project was the sealing of the old mine entries along the gorge wall. This was accomplished using hand tools and small mechanized equipment (where possible). At one entry, a latticed metal-bar grate was used to permit continued use by the 6 species of bats identified in the mines.

POPULATION STRUCTURE OF A SPRUCE-FIR FOREST IN THE GREAT SMOKY MOUNTAINS

--Richard T. Busing, University of Tennessee, Knoxville, Tennessee

Population size structure and age structure were determined for Picea rubens and Abies fraseri on the northeast slope of Mt. Collins (elev. 1750-1830 m). Tree species composition of the Mt. Collins stand is typical of old-growth spruce-fir forests in the Great Smoky Mountains (Oosting and Billings 1951). Size structure was estimated from DBH measurements of all trees (> 2.5 cm DBH) in six 0.1-ha quadrats. Age structure was estimated by sampling individuals in narrow strip transects. Age was determined by counting bud scale scars whenever possible. Other individuals were clipped at the base or cored near the base and aged by counting annual growth rings. The age of cored trees was adjusted using average height-to-age ratios to estimate age at bore height.

The size distributions of Picea and Abies fit an inverse-J curve typical of undisturbed, self-perpetuating populations. Individuals less than 5 cm DBH were abundant in both populations and frequencies declined rapidly in size classes greater than 5 cm. The maximum recorded size of Picea was 85 cm DBH, while the maximum recorded size of Abies was 55 cm DBH.

The age distributions of Picea and Abies also fit an inverse-J curve. Individuals less than 5 years of age comprised over 70% of each population. Less than 5% of the 253 Picea trees sampled were over 20 years of age, and less than 5% of the 431 Abies trees sampled were over 60 years of age. The oldest Picea individual was approximately 290 years of age, while the oldest Abies individual was approximately 130 years of age. Both of these ages were considerably lower than the maxima of 359 and 168 years obtained by Oosting and Billings (1951) for southern Appalachian Picea and Abies, respectively. These results suggest that very old trees comprise extremely small proportions of the populations.

Further sampling of old trees(> 100 yr) at the Mt. Collins site is ongoing.

INVASION OF MICROSTEGIUM VIMINEUM (POACEAE), AN EXOTIC ANNUAL SHADE-TOLERANT C₄ GRASS, INTO A NORTH CAROLINA FLOODPLAIN

-- Lawrence S. Barden, Department of Biology, University of North Carolina at Charlotte, Charlotte, North Carolina 28223

Microstegium vimineum was introduced into the United States about 1915. It has spread throughout the eastern states and is abundant on mesic, shaded, disturbed sites. It is an unusual species in that it is a C₄ plant that requires mesic soil conditions, usually under canopy shade. A three-year study of its population dynamics in a floodplain near Charlotte, NC, showed that: (1) M. vimineum was a poor invader of undisturbed ground vegetation. (2) It produced a seedbank that survived at least three years in the soil. (3) Even when sown in large numbers into undisturbed vegetation, it fared poorly. (4) Soil nutrients were not limiting in its growth. (5) When ground vegetation was disturbed by floods, weeding, or mowing, M. vimineum rapidly invaded and dominated the site.

PROGRESS REPORT: RIVER OTTER REINTRODUCTION IN GREAT SMOKY MOUNTAINS NATIONAL PARK

-- Jane Griess, Department of Forestry, Wildlife and Fisheries, University of Tennessee, Knoxville, Tennessee 37996

Between 26 February and 31 March, 1986, ten river otters (Lutra canadensis) were released on Abrams Creek in Great Smoky Mountains National Park. Four government agencies--the Tennessee Valley Authority, the National Park Service, the Tennessee Wildlife Resources Agency and the University of Tennessee--worked together to make this a successful project. All animals were purchased from a private trapper living in Newbern, North Carolina.

Upon arrival in Knoxville, all the animals were evaluated by personnel at the University of Tennessee College of Veterinary Medicine. Each animal was then held for a week prior to surgery. Animals were fed a diet of fish, supplemented with vitamins and antibiotics as prescribed by UT veterinary personnel. After a week, each animal was caught, sedated, weighed, measured, and implanted with a radio transmitter. Following surgery, animals were held 2 to 5 days prior to release to ensure full recovery from surgery. A sex ratio of 5 males and 5 females was released.

Since their release, the otters have been monitored on a daily basis. Eight of the otters have been consistently located. One otter, a young female, has not been located since her release day; transmitter failure is believed to be the reason. Another otter, a male, has been located at various intervals, but has not been located now for over three months. Animals are being monitored mainly by ground tracking; however, some aerial and boat tracking is also used. One male otter died two weeks after release. The cause of death is not known, but it is believed this was an old animal. The transmitter was removed and implanted in another male.

In addition to radio locations, scats and feeding site remains are being collected. While final analysis is not complete, preliminary findings indicate the otters have been feeding heavily on crayfish, fish and frogs. Field study on these ten otters will continue through the life of the transmitter or approximately July 1986.

GEOLOGICAL POSITION OF THE GREAT SMOKY MOUNTAINS IN THE APPALACHIAN MOUNTAIN BELT

--Nicholas B. Woodward and Jonathan C. Lewis, Department of Geological Sciences, University of Tennessee, Knoxville, Tennessee 37996-1410

The Great Smoky Mountains lie on a belt of deformed rocks transitional between the Valley and Ridge unmetamorphosed rocks, and the highly metamorphosed older rocks of the eastern Blue Ridge. The rocks in the Smokies represent a thick sequence of sandstones deposited on the continental margin of eastern North America between 800 and 600 million years (m.y.) ago. The Smokies are dissected geologically by several families of faults which probably range in age from Ordovician (450 m.y.) to Pennsylvanian (270 m.y.). Recent mapping and structural studies on rock fabrics document that the different fault groups seem to have distinct types of rock fabrics associated with them. Studies of the material properties of rocks under high temperature and pressure experimental conditions provide the bases for interpreting the rock fabrics found in the field. Smokies rocks were deformed either at rather deep (10-15 km) or rather shallow (5 km) levels. The rock fabrics also permit faults, which were previously unknown as to origin, to be placed within the well-established earlier fault family groupings. This approach has simplified some earlier explanations of the geological evolution of the Smokies and of the Southern Appalachian Mountain Belt.

DEBRIS SLIDES ON ANAKEESTA RIDGE

--P. T. Ryan and G. M. Clark, Department of Geological Sciences, University of Tennessee, Knoxville, Tennessee 37996-1410

The study of Anakeesta Ridge has the following objectives: (1) document slide development from the earliest aerial coverage to the present, (2) identify slide-prone areas based on slide localizing factors, (3) implement the infinite slope analysis, a slope stability risk index formula that incorporates slide localizing values; a factor of safety (FS) is generated such that a $FS > 1$ indicates stability, while a $FS < 1$ indicates slope instability, and (4) utilize slope instrumentation to extract critical slide localization data.

Anakeesta Ridge is located seven miles southwest of Gatlinburg, and less than a mile north of Newfound Gap. This east-west trending ridge covers an area of approximately two square miles and possesses a summit elevation range of 4000-5988 feet, with an average elevation of 5400 feet. The ridge is bounded to the north by second-order, dendritically-patterned Alum Cave Creek, and to the south by the third order Walker Camp Prong which is paralleled by U.S. 441. The underlying rock formation is the highly pyritiferous Anakeesta Formation. This rock unit consists of highly fractured and folded slate and phyllite which are imbedded with metasandstone.

At least since 1978, debris slides have been modifying Anakeesta Ridge, leaving a series of spectacular slide scars. Investigation of the slide scars reveals that failure occurred not only along the soil-rock interface, but also below this interface, within the highly oxidized Anakeesta formation, along bedding/cleavage release surfaces. Recent, very small debris slide scars have been observed along the south-central flank of Anakeesta Ridge. Associated with these slides is root throw; is it possible that root throw acts as

a water-concentrating zone such that slope failure is initiated by excessive pore-water pressure produced in the underlying, oxidized Anakeesta Formation? Within the larger slide scars, water seepage zones are observed along bedding and cleavage in areas where the Anakeesta Formation has been tightly folded. These zones are candidates for new failure surfaces.

In these preliminary investigations, it has become quite apparent that a need exists for a precise accounting of slide localizing factors: soil moisture, soil shear, soil permeability, pore water pressure, bedrock-soil shear strength, and bedrock-bedrock shear strength. If these factors can be determined under a variety of conditions, it will be possible to abandon a purely descriptive thesis for one that is predictive.

ROCK SLOPE STABILITY IN THE GREAT SMOKY MOUNTAINS NATIONAL PARK, TENNESSEE/NORTH CAROLINA

--C. Allen Torbett, P. T. Ryan and G. M. Clark, Department of Geological Sciences,
University of Tennessee, Knoxville, Tennessee 37996-1410

Eric C. Drumm and William F. Kane, Department of Civil Engineering, University of
Tennessee, Knoxville, Tennessee 37996

Rock slope failure in the Great Smoky Mountains National Park has been a pervasive problem in the past, and increasing development of the Southern Appalachian region enhances the likelihood of greater damages. This study involves a systematic analysis of five rock slopes along U.S. 441 in the park. An unstable slope is at the Clingmans Dome Road and U.S. 441 intersection. A stable slope is near the Morton Overlook. Three slopes, two failed, one stable, are positioned north of Gatlinburg along U.S. 441 north bound. Slope lithotypes consist of the Anakeesta Formation at both Clingmans Dome and Morton Overlook, and the Rich Butt Sandstone at the Gatlinburg locations.

Study techniques employed standard geological field methods and field measurements using a Brunton Pocket Transit and the Schmidt hammer. Measurements were taken on all major geologic discontinuities: faults, cleavage surfaces, bedding planes, and joints. Physical parameters measured include: slope height, slope orientation, tension cracks and joint density. The Schmidt hammer was used to estimate cohesion on failure plane surfaces. These values were used to evaluate the slopes on the basis of limiting equilibrium (the ratio of those forces resisting slides (FRS) to the forces which induce sliding (FIS)). The resulting ratio value (FRS/FIS) is considered the factor of safety (FS). A slope is considered stable when the $FS > 1$, and unstable when $FS < 1$. The condition of limiting equilibrium is attained when the forces resisting sliding are balanced by the forces that induce sliding. The moment of incipient sliding is when the $FS = 1$.

All slopes were analyzed using conservative assumptions yielding minimum values for FS. Unstable slopes that had failed yielded low values for FS ($< \text{or} = 1$) over the range of expected material properties, while stable slopes produced higher FS values (> 1.5). Factors that prove to exert the greatest effect on FS are cohesion along the discontinuity and the tension crack location; slope face or upper slope.

SORTED PATTERN GROUND IN THE GREAT SMOKY MOUNTAINS, NORTH CAROLINA/TENNESSEE

--C. Allen Torbett and G. M. Clark, Department of Geological Sciences, University of Tennessee, Knoxville, Tennessee 37996-1410

Fossil sorted patterned ground is located on the southwest aspect of Rocky Top, 4 km north of Spence Field on the Thunderhead Mountain 7.5' quadrangle (TVA #157SW). Rocky Top is a grassy bald in succession to a beech forest at an elevation of 1658 m underlain by the Precambrian Thunderhead Sandstone of the Ocoee Supergroup. The deposit consists of subangular cobbles and blocks of Thunderhead Sandstone forming sorted nets and blockstreams along the ridge crest. The sorted nets occur on the low angle crest, while the larger blockstreams occupy the southwest slope of Rocky Top. Sorted nets have block concentrations up to 1.5 m in diameter, with a preferred long axis orientation perpendicular to the slope. Blockstreams consist of an open framework of subangular blocks (20-200 cm) forming three trends trending down 26°- 30° southwest-facing slopes. The blockstreams are 2-4 m wide and trend downslope 150 m before grading into fluvially reworked talus.

Sorted patterned ground occurrences like these have been documented north of the Great Smoky Mountains along the crest of the Appalachians by several workers. These deposits are postulated relicts of geomorphic processes (solifluction or gelifluction) operative under cooler-than-present climatic conditions during the Late Wisconsinan glacial maxima. Palynological studies of other areas in and adjacent to the Blue Ridge have yielded circumboreal fossil pollen assemblages and C¹⁴ dates synchronous to Late Wisconsinan cold-phased times.

Description and characterization of the patterned ground at Rocky Top include: soil characterization, large scale mapping, slope profiling, sediment extraction for C¹⁴ and/or thermoluminescent dating and block fabric analysis. Macrofabric analyses underway indicate moderately strong upslope imbrication of block long axes which are oriented parallel to the slope direction. Though not unique to gelifluction, Brochu (1978) found 79.5% of solifluction deposits in the North American Arctic exhibit this upslope orientation, compared to less than 40% of gravity or fluvial deposits. This semiquantitative means to discern geomorphic process in conjunction with a chronological framework will aid in the understanding of the geomorphic history of the Southern Blue Ridge section of this geomorphic province.



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